Fluid-structure interaction in cardiovascular biomechanics: yes (because) we can ?

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There is much to be gained from patient-specific computational models complementing medical imaging and clinical data. Furthermore, recent examples from successful spin-off companies have learned that biomechanical modelling is no longer a priori restricted to the academic environment, provided that the output of the model pertains to the clinical setting and the clinician and that a workflow can be defined that is compatible with the clinical decision process. This also often implies efficient data handling and optimizing model complexity without compromising the validity and accuracy of the solution. In cardiovascular biomechanics, involving blood flow in passively or actively deforming structures, a choice that often needs to be made is whether or not to account for the fluid-solid interaction (FSI), or to what degree to account for it. Setting up an FSI problem is not a trivial task. As for any computational study, the wrong (combination of) boundary conditions may lead to non-physical and/or non-physiological results which may not always be appreciated from an analysis of the calculated flow field, but will certainly appear in the pressure field (which is only seldomly reported in FSI studies). The optimal strategy to set up the problem depends on the desired output of the model and the focus of the study. When it is the aim to account for the impact of the kinematics of cardiovascular structures on the blood flow, the structural problem can probably be solved with simplified constitutive equations, or the motion of (part of) the boundaries of the computational domain may even be imposed, provided that sufficient care is taken to ensure consistency between the imposed motion and the inflow- and outflow boundary conditions. The question whether full FSI simulations are always warranted when studying tissue biomechanics under a hemodynamics load is probably even more pertinent. In this presentation, using examples from my own research group and from literature, a review will be given of possible strategies to solve the fluid-structure interaction problem in cardiovascular biomechanics. The state-of-the-art and added value of fluid-structure interaction simulations will be addressed and discussed.